

ISO/FDIS_14635-2:2023(E)

ISO-/TC-60/SC-2

Secretariat: DIN

Date: 2023-01-25/03-03

Gears — FZG test procedures —

Part 2:

FZG step load test A10/16, 6R/120 for relative scuffing load-carrying capacity of high EP oils

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Engrenages — Méthodes d'essai FZG —

ISO/FDIS 14635-2

Partie 2: Méthode FZG A10/16, 6R/120 à paliers de charge pour évaluer la capacité de charge au grippage des huiles à valeurs EP élevées

FDIS stage

ISO/FDIS-14635-2:2023(E)

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
E-mail: copyright@iso.org
Website: www.iso.org

Published in Switzerland

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 14635-2

<https://standards.iteh.ai/catalog/standards/sist/068f00ae-ca28-4961-bd1c-511e14c9b05b/iso-fdis-14635-2>

Contents

Forewordv

Introductionvii

Part 2: FZG step load test A10/16, 6R/120 for relative scuffing load-carrying capacity of high EP oils1

1 Scope1

2 Normative references1

3 Terms and definitions1

4 Failure criteria2

5 Brief description of method4

5.1 General principle4

5.2 Precision5

6 Test materials5

6.1 Test gears5

6.2 Cleaning fluid5

7 Apparatus5

7.1 FZG spur-gear test rig5

7.2 Heating device8

7.3 Revolution counter8

7.4 Balance8

8 Preparation of apparatus9

9 Test procedure10

10 Reporting of results11

Annex A (informative) FZG A10-type gear tooth face changes (flank damages)13

Annex B (informative) Typical FZG test report sheet15

Annex C (informative) Checklist for maintenance of FZG gear test rig17

Bibliography23

Foreword — v

Introduction — vii

1 — Scope — 1

2 — Normative references — 1

3 — Terms and definitions — 1

4 — Failure criteria — 2

5 — Brief description of method — 3

5.1 — General principle — 3

5.2 — Precision — 4

6 — Test materials — 4

6.1 — Test gears — 4

6.2 — Cleaning fluid — 4

7 — Apparatus — 4

7.1 — FZG spur gear test rig — 4

ISO/FDIS 14635-2:2023(E)

7.2	Heating device	6
7.3	Revolution counter	6
7.4	Balance	7
8	Preparation of apparatus	8
9	Test procedure	8
10	Reporting of results	9
Annex A (informative)	FZG A10 type gear tooth face changes (flank damages)	11
Annex B (informative)	Typical FZG test report sheet	13
Annex C (informative)	Checklist for maintenance of FZG gear test rig	14
C.1	How to recognize malfunction	14
C.1.1	Distribution of scuffing marks	14
C.1.2	Tooth contact pattern	14
C.1.3	Tests with reference oil	14
C.1.4	Other indications	14
C.2	Parts that need maintenance	14
C.2.1	Test gear box	14
C.2.1.1	Shafts	14
C.2.1.2	Bearings	15
C.2.1.3	Keys	15
C.2.1.4	Spacer rings	15
C.2.1.5	Gear box and front cover	15
C.2.1.6	Seals	15
C.2.2	Connecting shafts and flanges	15
C.2.2.1	Load coupling	15
C.2.2.2	Torque measuring device	15
C.2.2.3	Load coupling support bearing	15
C.2.2.4	Torsion shaft	16
C.2.2.5	Flanges	16
C.2.3	Slave gear box	16
C.2.3.1	Slave gears	16
C.2.3.2	Lubrication	16
C.2.4	Other parts	16
C.2.4.1	Heating	16
C.2.4.2	Flexible coupling	16
C.2.4.3	Motor	16
C.2.4.4	Approximate time intervals	16
Bibliography		18

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/FDIS 14635-2](https://standards.iteh.ai/catalog/standards/sist/068f00ae-ca28-4961-bd1c-511e14c9b05b/iso-fdis-14635-2)

<https://standards.iteh.ai/catalog/standards/sist/068f00ae-ca28-4961-bd1c-511e14c9b05b/iso-fdis-14635-2>

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 60, *Gears*, Subcommittee SC 2, *Gear capacity calculation*.

This second edition cancels and replaces the first edition (ISO 14635-2:2004), of which it constitutes a minor revision in accordance with ISO Directives, Part 1. The changes are as follows:

The main changes are as follows:

- ~~ISO 1328-1:1995, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*¹~~ has been dated as this document still refers to accuracy grade;
- ~~replacement of ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*~~ which has been withdrawn and replaced by ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*;
- ~~replacement of ISO 4964, *Steel — Hardness conversions*~~ which has been withdrawn and similar information can be found in ISO 18265, *Metallic materials — Conversion of hardness values*;
- ~~updating~~ replacement of some bibliography entries ~~which were withdrawn~~, and changes from dated to undated references ~~where no specific reason requires the dated reference (see Bibliography footnotes)~~;
- ~~Clause 6.2, subclause 6.2~~, wording harmonized ~~within~~ with the ISO 14635 series;
- ~~Table 2, Table 2~~, description "~~pitch diameter circumferential speed (v_w)~~" has been replaced by "~~circumferential velocity at the pitch line~~" to harmonize the wording with the ISO 6336-series;

¹ Cancelled and replaced by ISO 1328-1:2013.

ISO/FDIS-14635-2:2023(E)

- ~~Table 5, Table 5,~~ insertion of line "Test lubrication volume" to conform to be compliant with the information ~~given within~~ in the ISO 14635 series;
- ~~Figure A.1, Figure A.1,~~ addition of the figure title.

A list of all parts in the ISO 14635 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html ~~www.iso.org/members.html~~.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 14635-2

<https://standards.iteh.ai/catalog/standards/sist/068f00ae-ca28-4961-bd1c-511e14c9b05b/iso-fdis-14635-2>

Introduction

The types of gear failures which can be influenced by the lubricant in use are scuffing, low-speed wear and the gear-surface fatigue phenomena known as micro- and macropitting. In the gear design process, these gear damages are taken into consideration by the use of specific lubricant and service-related characteristic values. For an accurate, field-related selection of these values, adequate lubricant test procedures are required. The FZG² test procedures specified in this [document](#) and ~~the other parts of ISO 14635-1 and ISO 14635-3~~, can be regarded as tools for the determination of the lubricant-related characteristic values to be introduced into the load-carrying capacity calculation of gears.

FZG test method A/8,3/90 for the relative scuffing load-carrying capacity of oils described in ISO 14635-1 is typical for the majority of applications in industrial and marine gears. This document is related to the relative scuffing load-carrying capacity of oils of very high EP properties, as used for the lubrication of automotive driveline components. Other FZG test procedures for the determination of low-speed wear, micro- and macropitting load-carrying capacity of gears are ~~already in a late state of development. They can intended to~~ be added ~~later~~ to [the ISO 14635 series](#) as further parts.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO/FDIS 14635-2](#)

<https://standards.iteh.ai/catalog/standards/sist/068f00ae-ca28-4961-bd1c-511e14c9b05b/iso-fdis-14635-2>

Gears — FZG test procedures —

Part 2:

FZG step load test A10/16,-6R/120 for relative scuffing load-carrying capacity of high EP oils

1 Scope

This document specifies a test method based on a FZG³ four-square test machine to determine the relative load-carrying capacity of high EP oils defined by the gear surface damage known as scuffing. This test method is useful for evaluating the scuffing load capacity potential of oils typically used with highly stressed cylindrical gearing found in many vehicle and stationary applications. It is not suitable for establishing the scuffing load capacity potential of oils used in highly loaded hypoid bevel gearing applications, for which purpose other methods are available in the industry.

NOTE This method is technically equivalent to CEC L-84-02.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1328-1:1995⁴, *Cylindrical gears — ISO system of accuracy — Part 1: Definitions and allowable values of deviations relevant to corresponding flanks of gear teeth*

~~ISO 5725-2, Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method~~

ISO 14635-1, *Gears — FZG test procedures — Part 1: FZG test method A/8,3/90 for relative scuffing load-carrying capacity of oils*

ISO 18265, *Metallic materials — Conversion of hardness values*

ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*

ASTM D 235, *Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/><https://www.electropedia.org/>

3.1

scuffing

particularly severe form of gear tooth surface damage in which seizure or welding together of areas of tooth surface occur, owing to the absence or breakdown of a lubricant film between the contacting tooth flanks of mating gears, typically caused by high temperature and high pressure

³ FZG = Forschungsstelle für Zahnräder und Getriebebau, Technische Universität München (Gear Research Centre, Technical University, Munich), Boltzmannstraße 15, D-85748 Garching, Germany.

⁴ Cancelled and replaced by ISO 1328-1:2013.

ISO/FDIS 14635-2:2023(E)

Note 1-to-entry: Scuffing is most likely when surface velocities are high. It can also occur at relatively low sliding velocities when tooth surface pressures are high enough either generally or, because of uneven surface geometry and loading, in discrete areas.

3.2

scuffing load-carrying capacity

(of a lubricant) maximum load which can be sustained under a defined set of conditions

Note 1-to-entry: It is the minimum load stage at which the failure criteria given in Clause 4 is reached. See Table 1.

3.3

FZG test condition A10/16,6R/120

test condition where A10 is the particular tooth form of the test gears, according to Tables 2 and 3, 16,6 is the speed at the pitch circle, in metres per second, "R" indicates the reverse direction of rotation (wheel drives pinion) and 120 is the initial oil temperature in degrees Celsius, from load stage 4 onward in the oil sump

3.4

failure load stage

load stage reached when the sum of the damage to the 16 pinion teeth exceeds 100 mm² in total area damaged

Note 1-to-entry: See Clause 4 and Table 1.

3.5

high EP oils

lubricants containing chemical additives appropriate for improving their scuffing load capacity

Note 1-to-entry: -EP = extreme pressure.

Note 2-to-entry: -These oils typically exceed the limits of the FZG test according to ISO 14635-1.

4 Failure criteria

Risk of scuffing damage varies with the properties of gear materials, the lubricant used, the surface roughness of tooth flanks, the sliding velocities and the load. Consequences of scuffing include a tendency to high levels of dynamic loading owing to an increase of vibrations, which usually leads to further damage by scuffing, pitting or tooth breakage.

Because of the particular gear design and test loads used, an interference area typically results at the tip of the pinion and root of the mating wheel. This area is usually about 1 mm in length (profile direction) on the pinion and across the entire facewidth. Examples of various levels of distress occurring with this test are shown in Annex A. The effect of the surface distress in these two regions is addressed as follows.

a) For the purpose of the visual rating for scuffing, the top 1 mm near the tip of the pinion is not included in the assessment until the damage extends below that level. The rated damage region is then expressed as the total area scuffed over all 16 pinion teeth (see Figure 1). The failure load stage is reached when the sum of the damage to the 16 pinion teeth exceeds 100 mm² in total area damaged.

b) For a valid test, the wheel shall be visually checked for signs of excessive wear after each pass load stage, as this could alter the results of the test. If there is evidence of wear in the dedendum of the wheel, then the gear shall be weighed to the nearest milligram (0,001 g) [see Annex A, Figure A.1 d]. The test may be considered valid only if the loss in mass of the wheel is ≤ 20 mg; if the loss in mass of the wheel exceeds 20 mg, the test shall not be considered valid.

See Table 1.

2 _____

See Table 1.

Table 1 — Test criteria

Pinion failure area <i>A</i> mm ²	Wheel wear Δm mg	Result
≤ 100	≤ 20	PASS
≤ 100	> 20 ^b 20	INVALID ^a
> 100	Not required	FAIL

^a— No statement on the scuffing load is possible.

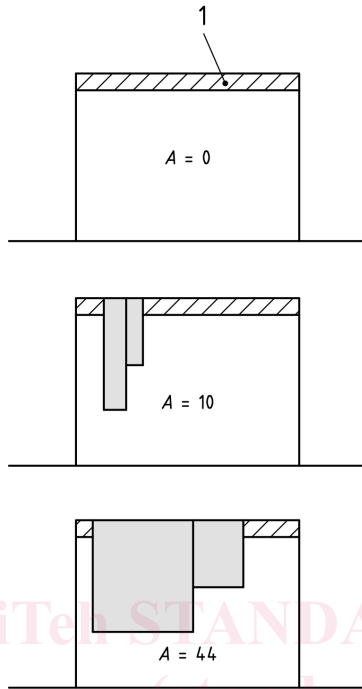
Area in square millimetres



iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 14635-2

<https://standards.iteh.ai/catalog/standards/sist/068f00ae-ca28-4961-bd1c-511e14c9b05b/iso-fdis-14635-2>



Key
1 exclusion zone (1 mm)

Figure 1 — Schematic of distress rating for pinion

5 Brief description of method

5.1 General principle

A set of test gears as defined in [Tables 2 and 3](#) is run with the test lubricant at constant speed for a fixed number of revolutions using dip-lubrication mode. Loading of the gear teeth is increased in steps outlined in [Table 4](#). Beginning with load stage 4, the initial oil temperature is controlled between 117 °C and 123 °C. During the test run of each load stage, the oil temperature is allowed to rise freely. After load stage 5, the pinion tooth flanks are inspected for surface damage at the end of each load stage and any changes in appearance are noted. A test is considered complete when either the failure criteria have been met or when load stage 10 has been completed without ~~having been met~~ meeting the failure criteria ~~having been met~~.

It is the responsibility of the operator to ensure that all local legislative and statutory requirements are met.

NOTE It has been assumed by the compilers of this test method that anyone using the method will either be fully trained and familiar with all normal engineering and laboratory practice, or will be under the direct supervision of such a person.

WARNING — When the rig is running, there are long loaded shafts and highly stressed test gears turning at high speed and precaution shall be taken to protect personnel.

Protection from noise is also highly recommended.

Deleted Cells

Deleted Cells